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Enumeration of the Peronosporæ of the United States.*

BY W. G. FARLOW.

In 1876 I published in the Bulletin of the Bussey Institution an account of the species of *Peronospora* and *Cystopus*, known at the time to occur in the United States, and the total number given was only ten. Having occasion recently to review the species of those genera in my collection, it occurred to me that, considering how many species have been added to our flora since 1876, it would be desirable to prepare a new list which should be as complete as the materials in my possession would permit, and, as the descriptions of some of the species are not accessible to many persons in this country who desire to study the subject, to add descriptions of all our species. The material examined has been specimens which I have collected myself and specimens in my herbarium, for which I am indebted to the kindness of several correspondents. In the arrangement of the synonymy I have endeavored to give the synonyms which are likely to be most frequently seen in text-books and agricultural treatises, and those who care for a detailed account of the synonymy of the more common species are referred to DeBary's original paper. Frequent references are made to American botanical works where our native species are mentioned; and where American specimens have been distributed in published exsiccati I have given the numbers, when they are known to me, without going so far as to quote European specimens of species which occur also in this country. The additions to our *Peronosporæ* are mainly scattered through the reports of the New York State Botanist, Mr. C. H. Peck, and in the Bulletin of the Bussey Institution, and Ellis's North American Fungi Century III. contains a num-

* This paper was presented at the meeting of the Society for the Promotion of Agricultural Science at Minneapolis, Aug. 14, 1883, and is now printed with the permission of the President, Prof. W. J. Beale.

ber of dried specimens of our species. I have incorporated in the list the species mentioned by Harkness and Moore in their catalogue of the Pacific Coast Fungi,¹ although, with a few exceptions, I have not examined specimens myself, but have given them on the authority of Dr. Harkness.

Our exact knowledge of the development and systematic position of the *Peronosporæ* dates from DeBary's classic monograph, *Recherches sur le développement de quelques champignons parasites*,² published in 1863, in which were described the greater part of our species. In a subsequent memoir, *Untersuchungen Ueber die Peronosporéen und Saprolegnien*,³ published in 1881, DeBary gives his views on the nature of the reproduction in *Peronosporæ*, and their relation to allied orders of fungi, so that, except perhaps with regard to the germination of the oospores, there remains almost nothing to be studied in connection with the history of the development of this group of fungi.

In his last paper DeBary includes in the *Peronosporæ* four genera: *Pythium*, *Phytophthora*, *Peronospora*, and *Cystopus*. In this country the species of *Pythium* have not been sufficiently studied, and no mention is made of them in this paper, although they possess a decided agricultural interest, since one species apparently causes what is known in some parts of the Eastern States as the potting bed fungus, which is very destructive to young house plants in the winter. Other species are known in decaying plants in damp ground. The species of the three remaining genera attack living plants, especially herbaceous exogens, and produce their oospores or resting spores in the interior of the leaves and young stems and bear their conidial spores on the surface. The oospores of all three genera are similar and produced in the same way, which can be learned from any of the recent text books of botany. They are globose and borne singly in an oogonium. They have two coats, the inner (Endospore) of which is first formed, while the outer (Exospore or Epispore) is formed, if one can say so, by a condensation of the surrounding protoplasm upon the endospore. In this way there is formed on the outer part of the oospore a covering which is either nearly smooth or marked with folds, ridges, or reticulations.

The three genera can not be distinguished from one another by their oospores, but the conidial spores serve to mark the

¹Cal. Acad. Science, Feb. 2, 1880.

²Annales des Sciences Naturelles, 4 Série. T. 20.

³Beiträge zur Morphologie und Physiologie der Pilze. DeBary & Woronin. 4 Reihe.

genera in question. In *Phytophthora* and *Peronospora* the mycelium in the interior of the leaves makes its way to the surface, in most cases passing through the breathing pores. That part of the mycelium which passes into the air and bears the conidia is called the conidiophore. In *Phytophthora* it is a simple or branching filament, at whose tip or tips is formed an ovate cell, the conidium. Before the conidium falls from its attachment the conidiophore, at its base, swells on one side and then grows upward, pushing the conidium to one side so that it appears to have been formed by a lateral outgrowth. The elongated conidiophore then bears a new conidium at its tip, which is in turn pushed to one side by the growth of the conidiophore, as before. The genus *Phytophthora* may then be recognized either by having one or more conidia borne laterally on the conidiophore, or, as is more frequently the case, by the swellings at intervals in the upper part of the conidiophore, indicating where conidia have fallen off.

In the genus *Peronospora* the conidiophore is a branching or rarely a simple filament which bears the conidia singly at the tips which do not afterwards elongate, as in *Phytophthora*. In a few species where the conidiophore is rather robust, instead of bearing a single conidium, the tip bears a number of short processes, or teeth, on each one of which is borne a conidium, as in *P. entospora* and *P. gangliiformis*.

In *Cystopus* the mycelium, instead of passing through the stomata into the air, collects in spots under the epidermis, which is then ruptured and turned back, and the filaments which correspond to the conidiophores in the other genera are very short and stout, and densely packed together and grow into simple chains of conidia by transverse cell division. Hence, while *Phytophthora* and *Peronospora* appear to the naked eye like fine frost like patches, especially on the under surface of the leaves, species of *Cystopus* produce dead white spots not limited to the under surface of the leaves.

The species of *Phytophthora* and *Cystopus* are few in number and it is not necessary to subdivide these genera, but as there is a considerable number of species of *Peronospora* it is usual to subdivide the genus. The subdivisions made by DeBary depend upon the mode of germination of the conidia; in the first division he places the species whose conidia give off a number of zoospores in germination; in the second, including only two species, the whole contents of the conidia are discharged in a mass which is not however motile, but which at once pushes

forth a new filament; in the third the conidia send out filaments directly from the apex; and in the fourth they produce filaments from any part of the surface but especially laterally. These subdivisions are based on physiological rather than morphological grounds, it will be seen, but it may be added that there is a more or less closely corresponding morphological difference. In the first subdivision with zoospores the ramification of the conidiophores is pinnate, if we except the anomalous *P. entospora*, which does not branch at all, and the minute *P. pusilla*, which can hardly be said to branch. The second division includes only two small species in which the ramification is not well marked. The third and fourth divisions run into one another, since the species of the latter sometimes germinate at the tip. As it is, the third division includes only one but a very distinct species where the ramification is dichotomous, but the tips are swollen and bear a number of radiating sterigmata. The species of the fourth and largest division are dichotomous and in several cases so much alike that they can hardly be distinguished by the conidiophores alone. The haustoria of the different sections are, to a certain extent, characteristic. In the first section they are of the spheroidal type, while in the last two sections they are generally filiform or club shaped, and frequently branch. A species of *Peronospora* can be said to be satisfactorily known only when both conidia and oospores have been observed and the germination of the conidia ascertained. The germination of the oospores has been seen only in a very small number of species, and this element can not be used in the systematic classification of the genus.

In spite of the small number of known species of *Cystopus*, our species, it must be confessed, are as yet unsatisfactorily known. This arises principally from the fact that the conidia alone are not sufficiently characteristic, and on several hosts oospores have not yet been found. In some of the species the conidia are all alike in shape, and in germinating they give off zoospores. In others the terminal conidia of the chains differ in shape from the rest, and are said, on the authority of Tulasne, to germinate by means of an outgrowing tube instead of by zoospores. The conidia of species of *Cystopus* are of two types, the spherical and the cylindrical, or cuboidal as they are sometimes incorrectly termed, but, without a knowledge of the oospores as well, it is evident that one can not safely unite forms on widely different hosts, guided only by the ill-marked distinctions afforded by the conidia.

PHYTOPHTHORA DeBary.

Conidia at first solitary and terminal, but becoming lateral by the outgrowth of the tip of the conidiophore. Several conidia produced in succession. Germination by zoospores.

PH. INFESTANS (Mont.) DeBary. Potato Rot.

Botrytis infestans Mont., *Bot. devastatrix* Lib., *Peronospora devastatrix* Casp., *Peronospora infestans* Casp., DeBary et al.
Exs. Mycotheca Universalis no. 926.

Mycelium slender, without haustoria. Conidiophores simple or with a few irregularly placed branches, attenuated at the apex, with one or more nodosities below at the insertion of the conidia. Conidia ellipsoid or oval with a terminal papilla. Oospores?¹

Common on cultivated potatoes from Maine to California (Harkness), and on tomatoes to South Carolina (Ravenel). Europe.

PERONOSPORA Corda.

Conidiophores variously branched or rarely simple, conidia always terminal. Germination either by zoospores or outgrowing tubes.

Section I. ZOOSPORIPARÆ. Conidiophores pinnately branching, ultimate divisions often glomerate. Germination by zoospores.

1. P. VITICOLA (Berk. & Curt.) DeBary.

Botrytis cana Schw. in Herb. Schweinitz non *B. cana* Lk.
Botr. viticola Berk. Crypt. Bot. 301; 23d Rept. N. Y. Bot. 61.
Per. viticola DeBary Ann. Sci. Nat. 4 Ser. T. XX. 121; Bull. Bussey Inst. I. 427; Grevillea III. 109, VI. 139. Bull. Ill. Mus. I. p. 55, pl. II. 687.
Exs. Mycotheca Universalis 617; Ellis North Am. Fung. 208; Ravenel Fung. Car. V. 60; Fung. Amer. 61.

Mycelium varicose, haustoria small, spherical. Conidiophores with a long, slender main axis, with a few short, subequal, alternate, horizontal 1 to 3 pinnate branches at the top. Tips acute, densely clustered in sets of usually three. Conidia small, ovoid-obtuse, average $17-23\mu$ by $13-17\mu$. Oospores about $30-38\mu$, rather thin walled, yellowish, exospore smooth or slightly wrinkled.

Common on wild and cultivated grapes east of the Rocky Mts. Europe. Algiers. Appearing with us in midsummer and autumn.

NOTE.—Since the introduction of our grape mould into Europe an immense amount has been written on its progress and prevention. In this connection the reader is referred to the latest work on the subject: *Le Peronospora des Vignes*, by Dr. Max. Cornu, 1882, in which the bibliography is very fully given with admirable plates of the fungus.

¹The oospores of this species are unknown to DeBary. Mr. Worthington G. Smith, in Gardener's Chronicle, July 17, 1875, and Quart. Journ. Micros. Sci., October, 1875, reported the discovery of oospores, and in the last named journal gave photographic copies of his preparation. The discussion which took place on this subject has frequently been quoted in American journals, and those who wish to examine the question more fully should consult DeBary's *Researches into the nature of the Potato Fungus*, Jour. Royal Agric. Soc. of England, and the two papers of Mr. Smith previously mentioned.

2. *P. HALSTEDII* Farlow.

Proc. Am. Acad. XVIII. 72.

Exs. Ellis N. Am. Fung. 209, 210.

Mycelium with oval haustoria. Conidiophores rather stout, undivided below, above with numerous 1 to 4 pinnate horizontal branches, the lower of which are considerably longer and more compound than the upper. Tips long, slender, acute, loosely diverging. Conidia oval or elliptic, $19-30\mu$ by $15-26\mu$. Oospores $23-30\mu$ in diameter, yellowish, thin walled, exospore with a few folds or ridges.

On *Ambrosia artemisiifolia*, *Eupatorium purpureum*, *Bidens frondosa*, *Rudbeckia laciniata*, *Silphium terebinthinaceum*, *Helianthus strumosus*, *H. doronicoides*, *H. tuberosus*, and *Solidago Canadensis*. Oospores on *H. doronicoides*.

From Mass. (Farlow) to Illinois (Burrill, Seymour), Iowa (Bessey, Arthur), Wisconsin (Trelease), and south to New Jersey (Ellis).

A widely diffused and apparently common species in the Northern States, but not yet reported from the Southern States. It may be expected to occur on almost any of the *Tubuliflorae* in midsummer and autumn. It can be distinguished from *P. viticola* by the more pyramidal outline of the conidiophores, the lower branches of which are usually decidedly longer than the upper, while in the ordinary forms of *P. viticola* the branches are all short, and by the longer less compact tips. The present species varies considerably, the form on *Helianthus* being very much branched and forming prominent woolly patches on the leaves, while in the form on *Ambrosia* the spots are minute and the branching less compound.

3. *P. OBDUCENS* Schroeter.

Hedwigia XVI. p. 129. Sept. 1877; Bull. Buss. Inst. II. 234; Proc. Am. Acad. XVIII. 70.

Exs. Ellis N. Am. Fung. 207.

Mycelium varicose, haustoria rather large, spheroidal. Conidiophores long and slender, branches slender, flexuous, loosely 2 to 3 pinnate, diverging in all directions, inserted rather acutely. Tips slender, acute. Conidia small, oval or ellipsoidal, $15-20\mu$ by $12-15\mu$. Oospores $30-40\mu$ in diameter, exospore yellowish, nearly smooth.

On *Impatiens fulva*.

Mass. (Farlow) to Illinois (Seymour) and Iowa (Bessey). Europe.

The species appears in the spring on the cotyledons, whose under side is densely covered by the conidia. Later in the season it forms small scattered spots on the leaves. The species is distinguished from the preceding by having the branches regularly arranged so that they diverge in all directions, while in the preceding they are very irregular, or with a tendency to a distichous arrangement. In this species the branches are not usually inserted at right angles, as in the preceding, but somewhat acutely. The tips are sharp and straight, but not so closely consolidated at the base as in related species.

4. *P. GERANII* Peck.

28th Report N. Y. Bot. p. 63.

P. nivea Ung. var. *Geranii* Farlow Bull. Buss. Inst. I. 426; Proc. Am. Acad. XVIII. 73.

EXS. Ellis N. Am. Fung. 218.

Mycelium large, with oval haustoria. Conidiophores short and delicate, axis naked below, bearing at the tip a few short horizontal 1 to 2 pinnate branches. Tips long, slender, divergent. Conidia broadly ellipsoidal, $17-23\mu$ by $15-18\mu$. Oospores $30-40\mu$ in diameter, exospore yellowish-brown, somewhat rugose.

On *Geranium maculatum* (oospores), *G. Robertianum* and *G. Carolinianum*.

Mass. (Farlow), New York (Peck), Michigan (Spalding), to Wisconsin (Trelease).

Found throughout the summer, forming large patches between the principal veins, sometimes almost covering the whole under surface of the leaves and causing yellow discolorations of the upper surface. Hardly to be distinguished from *P. nivea*. Differing from the preceding members of the section in its shorter main axis, its short and at times very condensed branches with longer spreading tips.

I have received from Mr. F. S. Earle specimens collected on *G. Carolinianum*, at Cobden, Ill., which were very puzzling. The conidiophores were very irregularly branched and scanty, and there were two kinds of conidia, some of the size given above, and others very much larger, in fact, enormous. On examination the large conidia were found to be borne, not on the conidiophores proper, but in the following manner: The mycelium in the leaf made its way to the stoma, but instead of growing upwards and branching it at once expanded into one or two enormous conidia which appeared to be resting on a stoma. A similar condition has been described by Cornu in *P. viticola*, but his figure is not so striking as the specimens from Illinois. The latter were collected in April, and a similar condition also exists in *P. Viola*, collected by Mr. Earle, also in April. It may be that this suppression of the ordinary conidiophore and the substitution of large sessile conidia is a common occurrence early in the season. In spite of their abnormal appearance I presume that the specimens on *G. Carolinianum* from Illinois probably are to be included under *P. Geranii*, but the scanty conidiophores did not present a typical appearance, but resembled somewhat those of *P. pusilla* Ung. Examination of a larger set of specimens is necessary to settle this form.

5. *P. NIVEA* (Ung.) DeBary.*Botrytis nivea* Unger Exanthem. 171.*Per. nivea* Ung. Bot. Zeit. 1847, in part; DeBary l. c. 101. Pl. IV; Cat. Pacif. Fung. 29.*Per. Umbelliferarum* Casp. Berlin Acad. Monatsber.

Haustroria obovate. Conidiophores short, bearing near the apex a few short horizontal 1 to 2 (rarely 3) pinnate branches. Tips subulate, straight, rarely subflexuous. Conidia subglobose, slightly papillate. Oospores large, with a pale yellowish-brown, smooth, or subrugose exospore.

On *Umbelliferae*. California (Harkness). Europe.

This common form on *Umbelliferae* in Europe is unknown to me in the United States, except from the catalogue of Harkness and Moore, on whose authority the species is inserted, the description being founded on European material.

Section II. BASIDIOPHORA. Conidiophores simple, surmounted by a number of sterigmata. Germination by zoospores.

6. P. ENTOSPORA (Cornu & Roze) B. & Br.

Basidiophora entospora Cornu & Roze Ann. Sci. Nat.

5me Série T. XI. p. 89. Pl. IV. f. 1-12.

P. entospora B. & Br. Grevillea, I. 20; Proc. Am. Acad. XVIII. 73.

P. Basidiophora Cornu Bull. Soc. Bot. France, XXV. 294.

P. simplex Peck, 31st Rept. N. Y. Bot. p. 45.

Conidiophores simple, stout, clavately swollen at the tip with numerous sterigmata on which are borne the very large, 26-32 η long, broadly ovate, papillate conidia. Oospores large, 34-41 μ in diameter, exospore marked with ridges.

On *Aster Novæ Angliæ*, *Erigeron Canadense* and *Solidago rigida*. Oospores on *Aster* and *Erigeron*.

New York (Peck) to Illinois (Burrill) and Wisconsin (Trelease). France, England, Germany.

Probably common in the United States, but first found in France, where it was probably introduced from America. It occurs from May to October, producing rather insignificant discolorations of the leaves. It has not yet been observed in New England. One of the most peculiar species of the genus, characterized by its simple conidiophores and very large conidia borne on sterigmata and perhaps rather to be regarded as a generic type.

Section III. PLASMATORARÆ. Conidia white, in germination the whole contents being discharged and forming a free globose cell from which grows a tube.

7. P. PYGMÆA Unger.

De Bary l. c. Pl. VII. f. 10-15; Bull. Buss. Inst. II. 233; 29th Rept. N. Y. Bot. p. 5;

30th Rept. p. 77; Cat. Pacif. Fung. p. 29.

Exs. Myc. Univ. 924; Ellis N. Am. Fung. 211.

Mycelium large, haustoria small, obovate. Conidiophores short, stout, unbranched except close to the apex where there are a few rudimentary branches. Conidia ovate, 20-26 μ by 15-19 μ , papillate. Oospores large, dark brown, thick-walled, 45-53 μ in diameter, exospore slightly rugose.

On *Anemone nemorosa*, *A. Pennsylvanica*, and *Hepatica triloba*.

Mass. (Farlow), New York (Peck), Illinois (Seymour), to California (Harkness). Europe.

A common species on *A. nemorosa* in the Eastern States during the spring and early summer, often accompanying other fungi. I have been able to examine specimens on *A. nemorosa* only where the conidiophores are stout and scarcely branched at all. What is called by De Bary var. *elongata* I have not seen in this country.

Section IV. ACROBLASTÆ. Conidia white, germinating by a terminal tube. Ramification dichotomous.

8. *P. GANGLIFORMIS* (Berk.) De Bary.

Botrytis ganglioniformis Berk. Lond. Jour. Hort. Soc. I. 51. Pl. 4.

P. ganglioniformis Tul. Compt. Rend. XXXVIII, 26.

P. gangliiformis De Bary l. c. Pl. VIII. f. 1-3; Bull. Buss. Inst. I. 427; Cat. Pacif. Fung. p. 29. Bull. Ill. Mus. I. p. 551, pl. II. 3.

Exs. Ellis N. Am. Fung. 219

Mycelium with ovate haustoria. Conidiophores simple below, slender, becoming several times dichotomous, the divisions often recurved, swelling at the tip into clavate or cup-shaped bodies from which radiate several sterigmata. Conidia small, globose or ellipsoidal, 16-23 μ by 16-20 μ . Oospores yellowish, thin walled, 26-34 μ in diameter. Exospore smooth.

On *Nabulus albus* (oospores), *Lactuca altissima*, *L. Canadensis*, *L. sativa*, and *Mulgedium leucophæum*.

New Hampshire, Mass., New York (Farlow), Iowa (Bessey), Illinois (Burrill), to Wisconsin (Trelease). Europe.

A species easily recognized by the swollen or cup-shaped tips from which radiate a few sterigmata. It does considerable harm near Boston and New York to early lettuce raised in hot-beds. I have seen oospores on *Nabulus albus* only. The species is apparently common with us and will be found on several other hosts than those mentioned above. It has not yet been seen in this country on *Senecio vulgaris* on which it produces oospores in Europe.

Section V. PLEUROBLASTÆ. Conidia white or violet colored. Germination by tubes given off from any part of the conidia, but especially the sides. Ramification dichotomous.

A. *Parasiticeæ*. Wall of oogonium thick and rigid. Oospores with a thin, smooth exospore.

9. *P. PARASITICA* (P.) Tul.

Botrytis parasitica Persoon Observ. I. 96.

P. parasitica Tul. Compt. Rend.; De Bary l. c. p. 106, Pl. IX. f. 5-8; Bull. Buss.

Inst. I. 428; 26th Rept. N. Y. Bot. p. 79; Cat. Pacif. Fung. p. 29.

P. Dentarie Rabh. Fung. Eur. 86.

Exs. Ellis, N. Am. Fung. 212.

Mycelium large, with very large clavate or branching root-like haustoria. Conidiophores stout and simple below, branching above, rather abruptly and irregularly dichotomous, the divisions dense, slender and flexuous. Tips subulate, curved. Conidia white, broadly ellipsoidal. Oospores 26-43 μ in diameter. Exospore brown and nearly smooth.

In *Capsella Bursa-pastoris*, *Lepidium Virginicum*, *Brassica sativa*, *Rhaphanus sativus*, *Cardamine rhomboidea*, and *Dentaria laciniata*. Oospores on *Cardamine* and *Dentaria*.

Mass. (Farlow), New York (Peck), to Delaware (Farlow), North Carolina (Curtis) and west to Wisconsin (Trelease), Kentucky (Kellerman) and California (Harkness). Europe.

A common species on *Cruciferae* in all parts of the country, often in company with *Cystopus candidus*, on which it was once believed to be parasitic. It occasionally causes considerable damage to the cabbage crop. On *Lepidium* and *Capsella* it covers the under surface of the leaves with a dense fleece, but on

cabbages and *Cardamine* it is less dense. The oospores are not very frequent, considering how common the species is. Although subject to considerable variation, the species is comparatively easily recognized by the stout conidiophores which are abruptly dichotomous above, the divisions being slender and densely ramified. The haustoria are especially large and easily studied. The form on *Dentaria* from Kentucky corresponds precisely with Rabenhorst's original specimens of *P. Dentariae*.

10. *P. POTENTILLÆ* De Bary.

De Bary l. c. p. 120; Bull. Russ. Inst. 233; Cat. Pacif. Fung. 29.

Exs. Ellis N. Am. Fung. 217.

Conidiophores slender, several times dichotomous, divisions distinctly flexuous. Tips attenuate, approximate in pairs, curved. Conidia violet colored, ellipsoidal, 20–26 μ by 15–19 μ . Oospores yellow, thin-walled, smooth, 22–24 μ in diameter.

On *P. Norvegica*.

Mass. (Farlow), California (Harkness). Europe.

As far as I am aware the oospores of this species have never been described. I found them on *P. Norvegica* in October, 1877. The oogonium is very thick-walled and rigid, and is almost completely filled by the oospore, which is almost exactly spherical and has a thin, smooth wall. In fact, at first sight, one would mistake the oogonium and its contents for a single thick-walled oospore so completely does the oospore fill the oogonium in most cases. In consequence of the structure of the oogonium, the present species must be placed in the same section as *P. parasitica* if we follow De Bary's classification. The species is common in Massachusetts from June to October. I have no specimens from the Western States, although I have heard that the fungus grows in that region.

In July, 1882, I found a *Peronospora* on *Geum album* at Wood's Holl, Mass., but it was not fully developed, and no oospores were seen. It formed ill-defined spots on the under side of the leaves, which showed a yellowish discoloration on the upper side. I presume that the form on *Geum* must be included in *P. Potentillæ*, although the conidiophores were more slender and less branched. At any rate, without more material, I should not venture to separate it as a distinct species.

11. *P. CLAYTONIÆ* n. sp.

Conidiophores long, naked below, several times dichotomous above, divisions short, flexuous. Tips short, subulate, widely spreading. Conidia broadly obovate, violet-colored, 22–24 μ by 15–20 μ . Oospores large, 38–45 μ in diameter, brown, exospore more or less rugose.

On *Claytonia Virginica*.

Kentucky. Comm. J. B. Ellis.

The only specimens of this species which I have seen were those sent by Mr. Ellis. The leaves of the *Claytonia* were wrinkled and blackened, but no definite spots were found. The conidiophores were rather diffusely scattered, and the oogonia were large and did not contract around the spherical oospores,

which were brown, thin-walled and considerably smaller than the oogonia. The rigidity of the oogonium wall and other characters given above lead me to place the species in the present section, although it approaches the section *Effusæ*.

B. *Calothecæ*. Wall of oogonium thin, wrinkled at maturity. Exospore not smooth, but regularly tuberculose, verrucose, or reticulated. Haustoria filiform, branching.

12. *P. MYOSOTIDIS* DeBary.

DeBary l. c. p. 108. Pl. XIII, f. 5; Rabh. Fung. Eur. 572.

Conidiophores long, slender, several times dichotomous, ultimate divisions slender, widely spreading. Conidia ovate-obtuse $20-23\mu$ by $15-18\mu$, faintly violet colored. Oospores rather small, $24-30\mu$ in diameter, dark brown, exospore marked with regular reticulations.

On *Myosotis verna*.

Chebacco Lake, Mass. (Seymour), Cobden, Ill. (Earle). Europe.

Found on the leaves, especially the lower ones, in spring. Apparently not common. Recognized by the beautifully reticulated oospores which accompany the conidia in all the American specimens I have examined.

13. *P. ARTHURI* n. sp.

Conidiophores rather short and rigid, several times dichotomous. Tips rather short and rigid. Conidia broadly ellipsoidal, obtuse, $22-26\mu$ by 19μ , slightly violet-colored. Oospores large, dark brown, $34-42\mu$ in diameter, exospore covered with short blunt papillæ.

On *Enothera biennis*.

Iowa (Arthur), Minnesota (Farlow).

This species, first detected by Prof. Arthur in Iowa, was found abundant on the shore of Lake Minnetonka, Minn. The fungus covers the under surface of the leaves in large patches, and the upper side of the leaves becomes pale yellow. The species is quite distinct from *P. Epilobii* Rabh., the conidiophores of which, as shown by Fung. Eur. no. 1747, are rather of the pinnate type, and whose conidia are not violet colored, but white. The papillate oospores also serve to distinguish the present from our other species. A form of *Peronospora* on *Enothera* from New York is referred by Peck in his 30th Report to *P. effusa*.

14. *P. VICIÆ* (Berk.) DeBary.

This species, closely related to *P. Myosotidis*, and common in Europe on *Papilionaceæ*, is reported by Harkness and Moore to occur on pear leaves in California. It may, perhaps, be asked whether this is not a misprint for pea leaves. Certainly the species is not known elsewhere on pear leaves.

[TO BE CONTINUED.]